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Historical Changes in Soil Erosion, 1930-1992

The Northern Mississippi Valley Loess Hills

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H. Raymond Sinclair, Jr.

Cover photograph: Coon Creek watershed, Vernon County, Wisconsin. Tim McCabe. 1994.

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The Northern Mississippi Valley Loess Hills

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Foreword

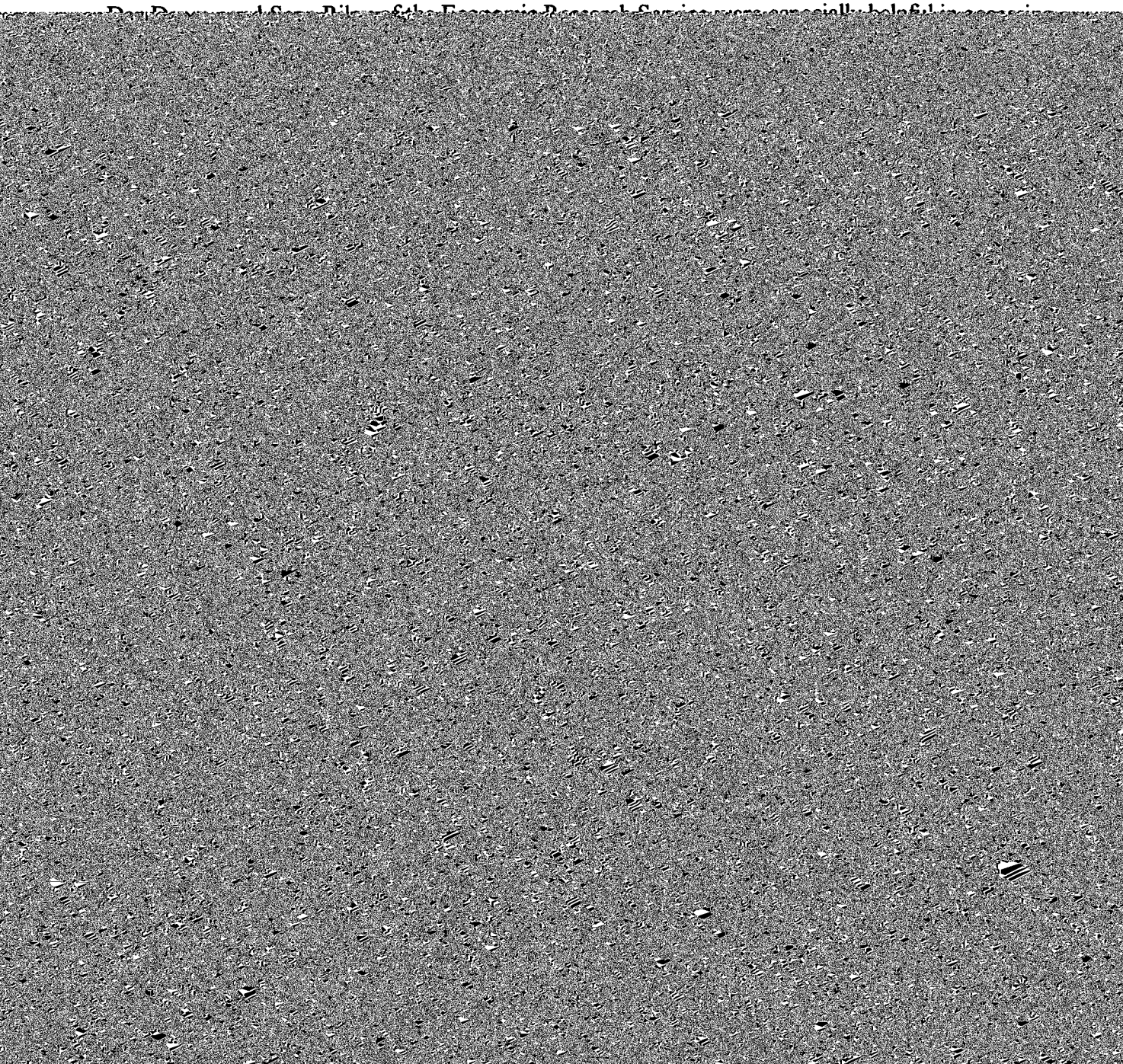
This is a study of soil erosion conditions in the 1930's as opposed to 'now' (1992) in a major land resource area of the humid region, the Northern Mississippi Valley Loess Hills (MLRA

gullies and stream bank erosion. At about the same time the U.S. Department of Agriculture (USDA) had established a number of Conservation Experiment Stations across the country, one of which was located at nearby La Crosse, Wisconsin.[1]

Determining how effective individual conservation efforts and public programs for research, technical assistance and cost sharing have been in reducing soil erosion in a broad region like MLRA 105 was a main object of this interdisciplinary study. A second object was to illustrate a methodology whereby long-term changes in erosion conditions are determined for this region which should be applied

Northern Mississippi Valley in the 1930s and 1940s. Also, in August 1995 Rocky Taign of the Elkader Field Office of the Natural Resources Conservation Service assisted in locating sites where repeat photographs of land uses and conservation practices could be obtained.

Out of print and current State crop reports covering all counties in the study area were obtained through William Dowdy of the Crops Branch in the National Agricultural Statistics Service, with additional help from Garry Kepley, George Howse, Bernie Jansen and other personnel in Illinois, Minnesota and Iowa. Advance county sheets from the 1992 Census of Agriculture and assistance in interpreting land use items in the older Censuses were provided by Robert Smith and Debra Norton of the Census Bureau's Agriculture Division. William Lindamood, Edward Reinsel, Robert Reinsel,



Executive Summary

Changes in soil erosion conditions between 1930 and 1992 have been evaluated for the Northern Mississippi Valley Loess Hills, sometimes called the "Driftless Area" of the Northern Mississippi Valley. As naturally defined, this area includes 18,860 square miles (12.1 million acres) covering the major part of 28 counties--six counties in northeast Iowa, six counties in southeastern Minnesota, 15 counties in southwestern Wisconsin and a single county (Jo Daviess) in the northwest corner of Illinois (figure 1).

Five of the 28 counties were chosen as a sample for which land uses, farm management practices, farming methods, and crop and livestock enterprises during the years 1925-1935 were researched from early USDA Soil Surveys, State Experiment Station Research Bulletins, and Agricultural Census reports. This information was used to 'reconstruct' rates of soil loss for the base year 1930 on land used for row crops, oats and other small grains, and rotation meadow. The sample counties were: Clayton County, Iowa; Houston and Winona Counties, Minnesota; and Crawford and Vernon Counties, Wisconsin.

The Universal Soil Loss Equation (USLE) developed by Wischmeier and Smith of USDA's Agricultural Research Service was used to calculate erosion rates per acre of land in these crops. The formula integrates the influences on erosion of rainfall, soil erodibility, field slope and slope length, cropping sequences, crop yields, tillage practices, and any supporting conservation measures. The erosion rates for 1930 calculated for the sample counties were compared with erosion rates for 1982 and 1982. The 1982 and 1992 rates, also based on the USLE, were made available from the National Resources Inventories of the Natural Resources Conservation Service.

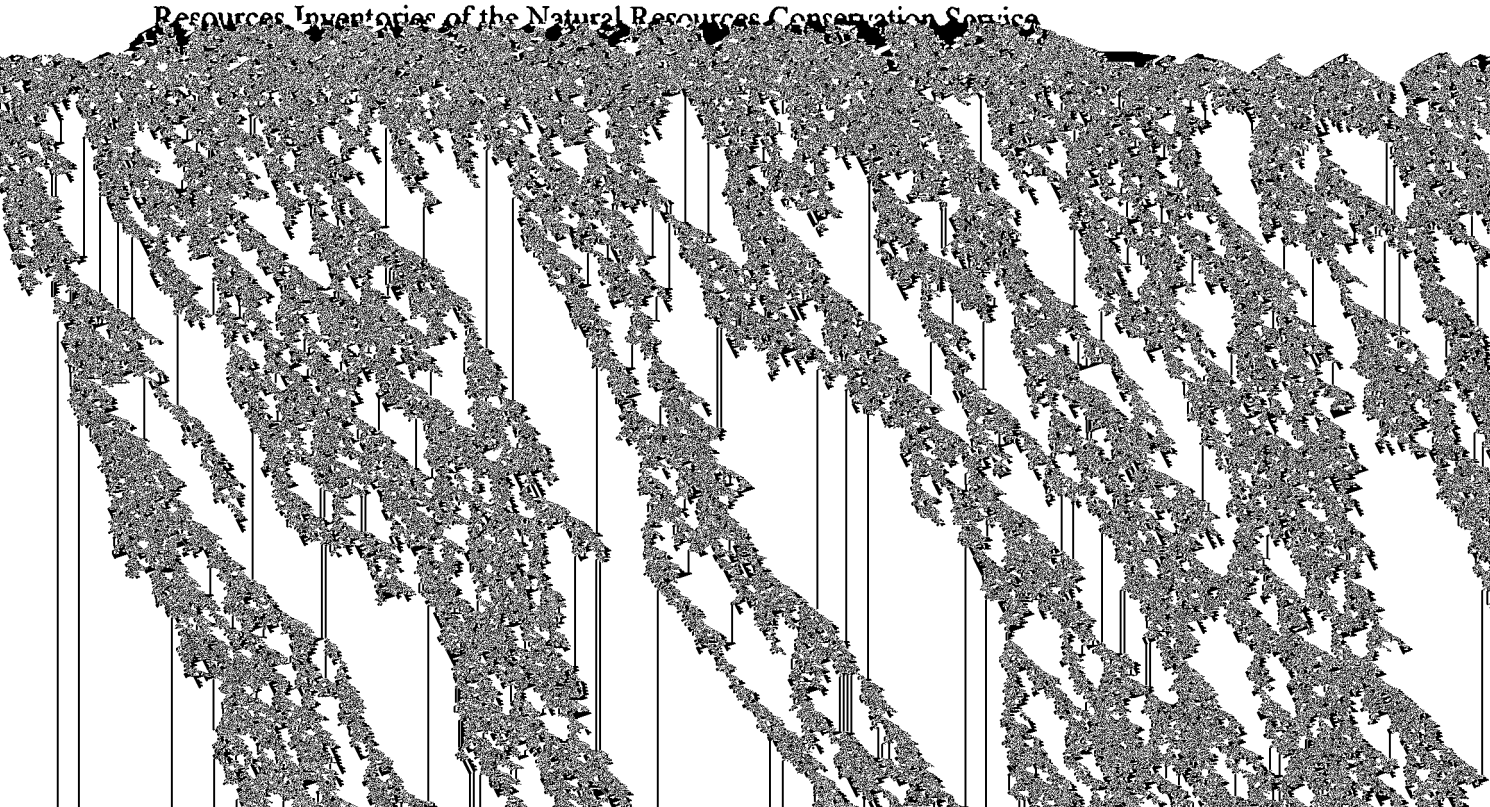
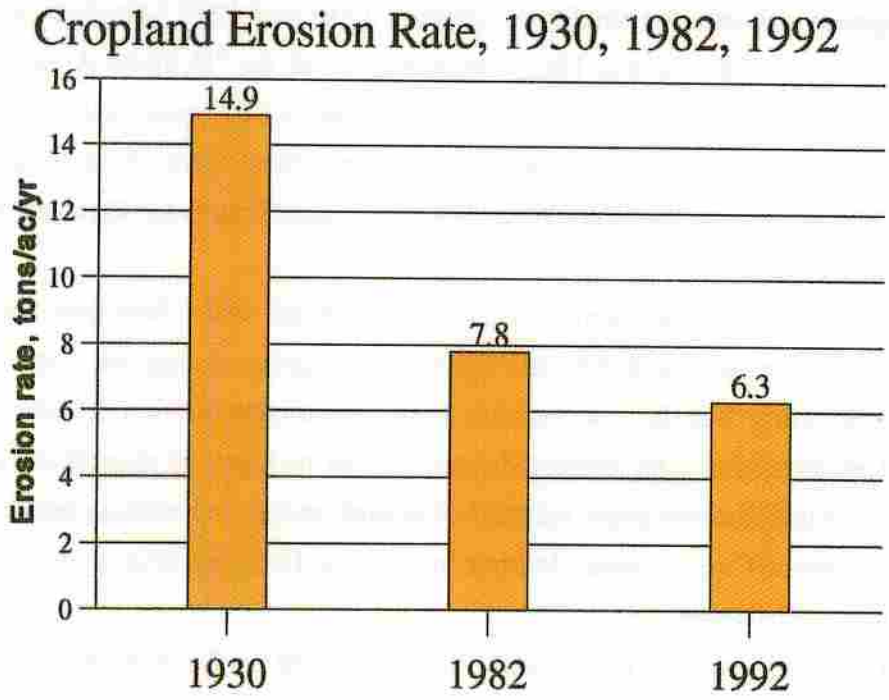


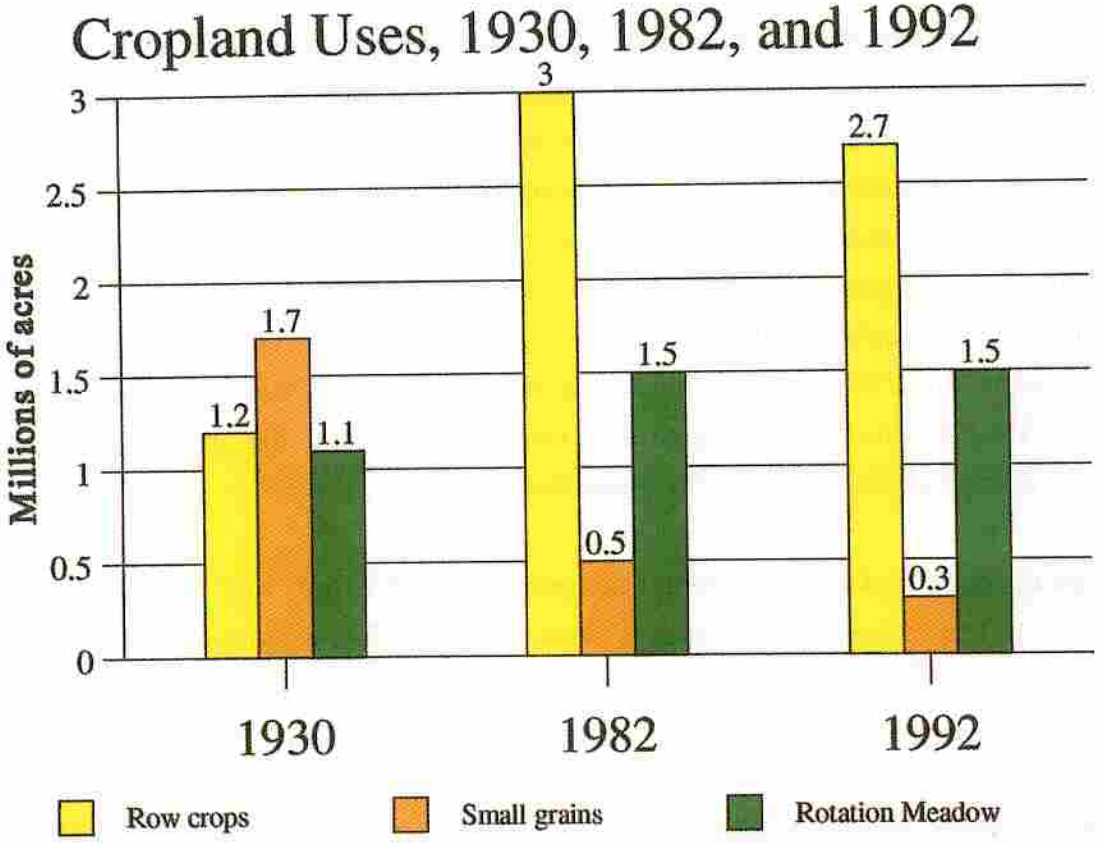
Chart A



When multiplied by the acres in principal crops the reduced gross erosion rates per acre from 1930-1992 translate into a reduction of between 42 and 58 percent in the total or 'gross' amount of

(WEQ) was only 42 percent of the rate we estimated for 1930, and the total amount of soil being displaced on cropland in 1992 was only 49 percent of the amount displaced in 1930. These reductions were achieved despite the area used for row crops, small grains or rotation meadow in 1992 being 16 percent greater than in 1930. The area in row crops alone in 1992 was 2.3 times the

Chart B



area in row crops in 1930-- 2.7 million acres in 1992 as compared to 1.2 million acres in 1930.

Chart B compares the use of cropland for row crops, small grains and rotation meadow in 1930, 1982 and 1992. Note that the combined area in row crops or small grains in 1992 (3.0 million acres) was less than the area in 1982 (3.5 million acres), by about 500 thousand acres. The 678 thousand acres in the Conservation Reserve Program in 1992 doubtless included significant acreages cropped in 1982, but also some cropland that was not being farmed in 1982.

It appears that the [illegible]

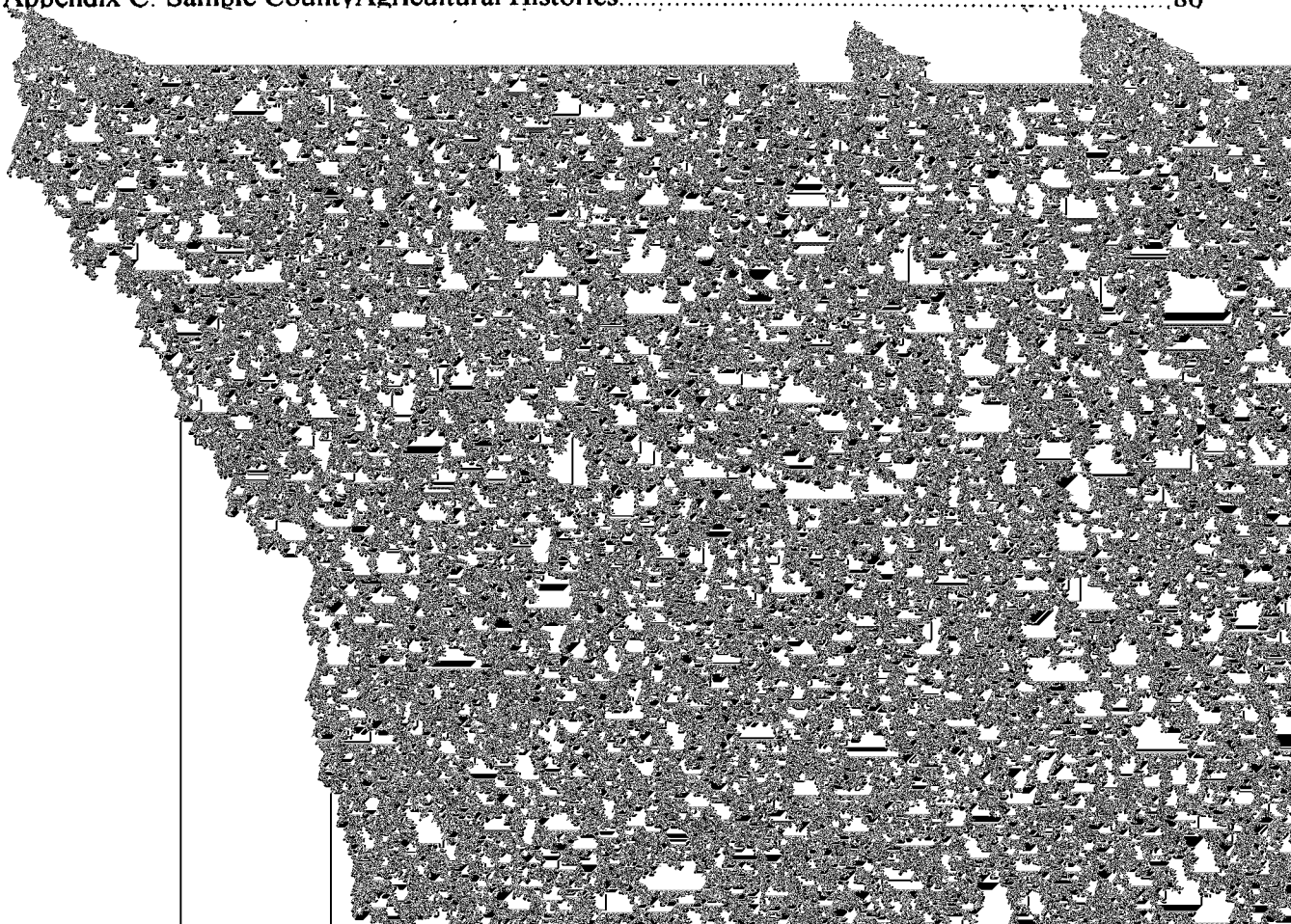
improvements, practicing superpopping, and reducing tillage.

4. Farmers of today are also conservation minded but their situations and tactics differ. The apparent tendency is to plant row crops wherever feasible, but to install the necessary land improvements like terraces, farm slopes on the contour and minimize tillage operations.

5. Soil erosion has been greatly reduced since 1930 in the Driftless Area of the Northern Mississippi Valley, but the results of our study do not necessarily apply elsewhere. Agriculture is too dynamic and diverse to warrant such generalizations. However, this study does offer a clear corrective to the sweeping generalizations which claim that soil erosion has remained static or worsened since the midst of the Great Depression and the dust bowl days of sixty years ago.

6. This study represents an original effort to quantify soil erosion losses 60-plus years ago across a broad region. The numerical results, while reliable, should not be regarded as exact. Climatic conditions and basic soil characteristics may not have changed much, but it is virtually impossible and in any case would be prohibitively expensive to determine exactly how each farm field was managed in the 1930s. The results we give reflect our best judgement as to which source data, assumptions, and analytical methods to apply to the problem. In this sense our findings can be regarded as accurate representations of farming and erosion conditions in the 1930s and the present time. Further, the continued conversions to no-till farming and other variations of conservation tillage suggest that the expected average annual erosion rate on cropland as of 1995 is measurably less than the 6.3 tons/ac/yr we estimated for the year 1992.

Contents



Tables*

Table 1. Severity of erosion in Clayton County, Iowa and Winona County

HISTORICAL CHANGES IN SOIL EROSION, 1930-1992
The Northern Mississippi Valley Loess Hills, MLRA 105

Background

This study determines changes in soil erosion conditions between 1930 and 1992 in a selected Major Land Resource Area of the United States, the Northern Mississippi Valley Loess Hills (MLRA

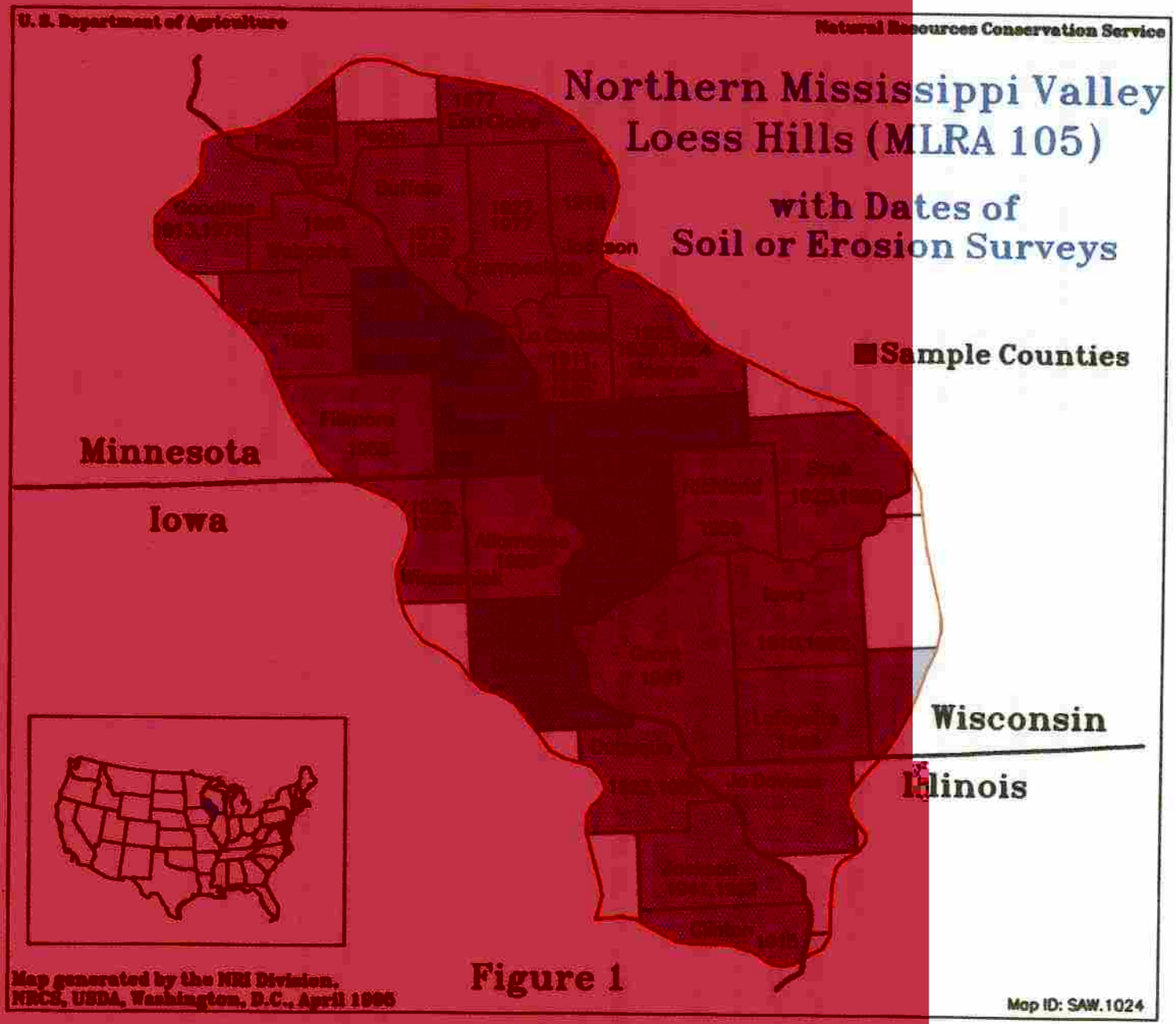

U. S. Department of Agriculture
Natural Resources Conservation Service
Northern Mississippi Valley
Loess Hills (MLRA 105)
with Dates of
Soil or Erosion Surveys
Sample Counties
Minnesota
Iowa
Wisconsin
Illinois
Map generated by the NRI Division,
NRCS, USDA, Washington, D.C., April 1996
Map ID: SAW.1024

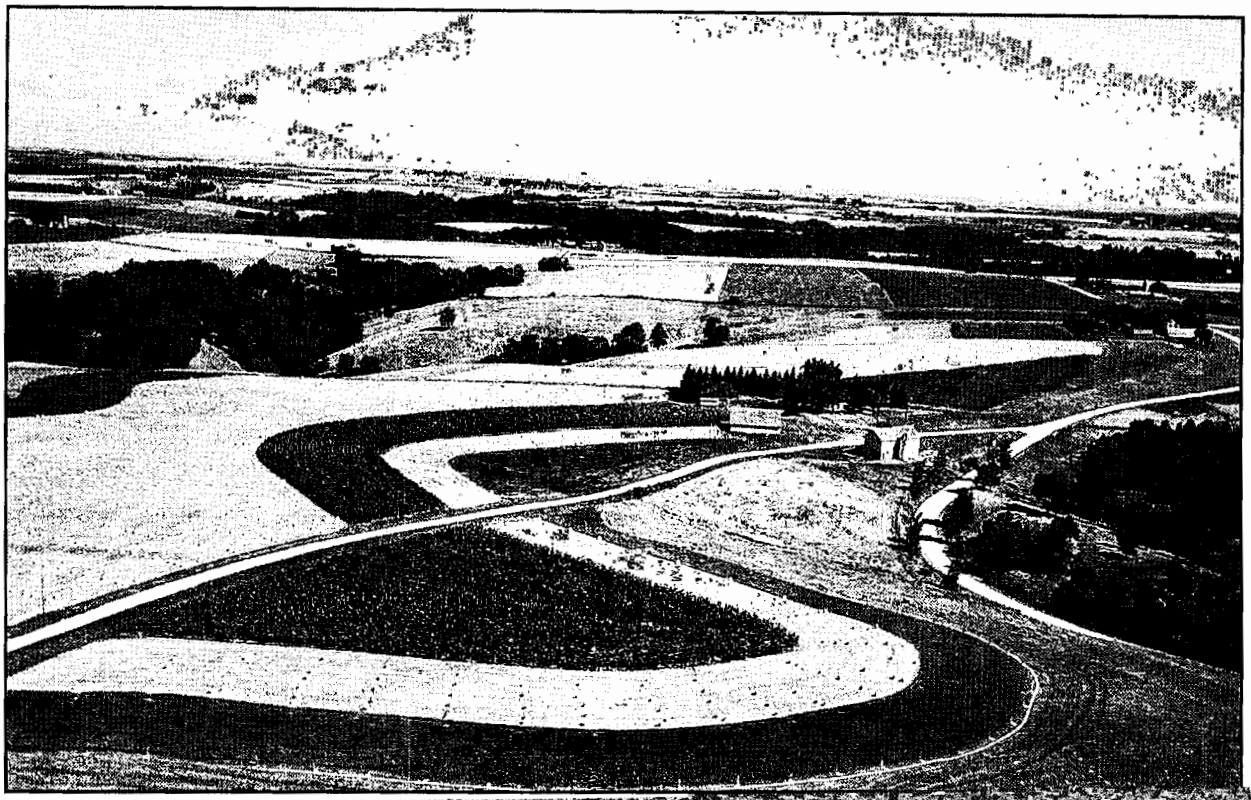
Figure 1

significance.[3] This study focuses on soil 'displacement', and is called 'gross erosion', This is not necessarily equivalent to soil 'loss'.

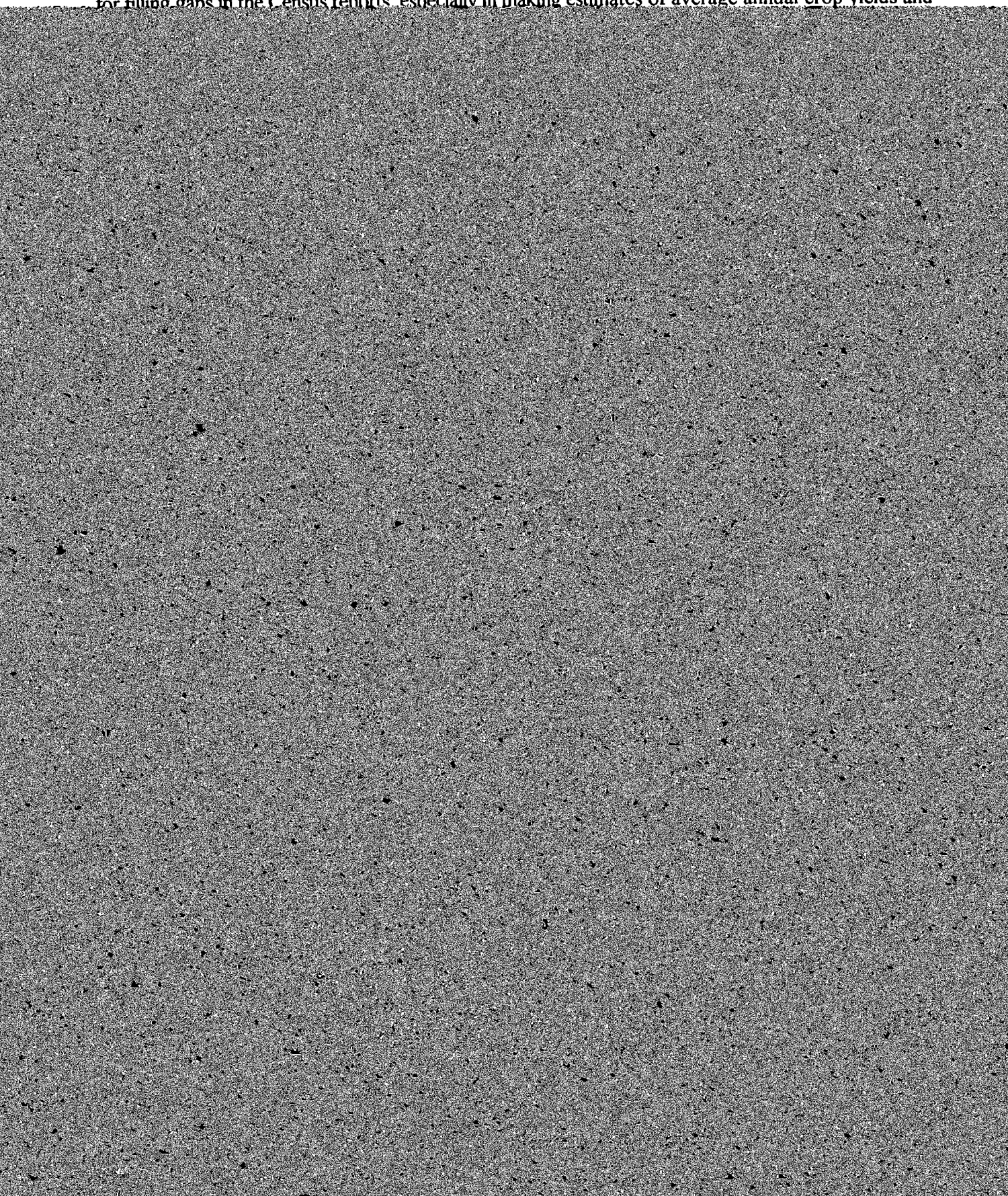
The early applied economic studies dealt mostly with representative farm situations on a with- versus a without conservation level, but not tied to physical measures of soil loss (Ball and Heady,1957). Two conceptual studies for economic analysis are those of Bunce (1942), and Heady and Jensen (1951). They foresaw the need for and likely emergence of interdisciplinary research on evaluation methods and field problems.

As sedimentation and related water quality problems of nonpoint origin have become more obvious and of concern to the public, research studies have tended to encompass wider areas. Soil and water management issues, both onsite and offsite, and of both production and environmental importance, are best treated within overall frameworks that recognize and balance the interests of

Continued Use of Conservation Practices at Former SCS/USDA Demonstration Projects



for filling gaps in the Census reports, especially in making estimates of average annual crop yields and



Farming systems and practices in the decade 1925-1935, as related to crop decisions, soil management problems, tillage and residue practices and conservation efforts are researched in some detail. This information was essential for determining proper values for the cover-management and conservation practice factors in the USLE. The USLE is then applied retroactively to 1930 in MLRA 105 with reference to climatic and soils information, available cropland, crop groups, crop rotations and sequences, tillage methods and residue management practices.

The estimated erosion rates for 1930 are compared with those estimated for the same five sample counties from USDA's 1982 and 1992 National Resources Inventories (NRI). The NRI rates of soil loss are similarly based on the USLE. These reflect the adoption of conservation practices

Table 1. Severity of erosion in Clayton County, Iowa, and Winona County, Minnesota, ca. 1934

Erosion degrees	Clayton County, IA [1]		Winona County, MN [2]	
	Acres	Percent on cropland	Acres	Percent on cropland
No apparent erosion	891	36	7,216	4
Slight erosion	2,560	82	195,541	32
Moderate erosion	3,258	90	122,763	81
Severe erosion	2,787	94	48,939	84
Very severe erosion	74	100	6,253	90
Totals, all degrees	9,840	85	374,712	56

[1] Data for Clayton County refer only to the Farmersburg-McGregor Project area. See U.S. Dept. Agriculture, Soil Conservation Service. 1942. *Physical Land Use Conditions on the.Farmersburg-McGregor Project, ClaytonCounty, Iowa (D.E. Perfect and D.A. Sheetz).* Physical Land Survey No. 28. 25pp.

[2] Data for Winona County refer to the entire county. See U.S. Dept. Agriculture, Soil Conservation Service. 1936. *Erosion and Related Land Use Conditions in Winona County, Minnesota (M. H. Brown and I. F. Nygard).* Erosion Survey No.17. 27pp.

A similar situation was reported in a county-wide field study for Winona County, Minnesota. About 55 percent of all erosion, but between 84-90 percent of the severe and very severe erosion was said to be on cropland. By degrees of erosion severity, total lands eroding and percentages occurring on cropland in Clayton and Winona Counties in the 1930s are in table 1.

Comparable numerical estimates on cropland erosion are not available from early reports for the Coon Creek Project in La Crosse, Monroe, and Vernon Counties in Wisconsin, but serious soil erosion was said to occur because of the continued use of cropland, pasture, and woodland without regard for land capability or corrective conservation measures (USDA,1939,p.28).[4]

[4] For the ten sub-basins they studied, Trimble and Lund estimated annual gross erosion rates across all land uses of about 13.4 tons per acre under 1934 conditions, rates that had been reduced to 3.28 tons per acre by 1975 (Trimble and Lund,1982,pp.10-11). Specific estimates for cropland were not given.

1944 scene of stripcropping on Oscar Henkes farm near Farmersburg, Iowa, in the Farmersburg-McGregor Demonstration Project. Photo from Project files.

1995 repeat photo: Farm now owned by Lou Schrandt, showing that contour stripcropping is still being practiced. Photo by Douglas Helms, NRCS/USDA. August 1995.

Selection of Sample Counties

Information on erosion rates for different land uses and areas as of 1982, 1987, and 1992 are available from USDA's 1992 National Resources Inventory (NRI). Estimates of needs for erosion. control were also made in these NRI's, and also in those completed in 1958 and 1967. Findings of the 1934 Reconnaissance Erosion Survey (RES) and the successive NRI's are not directly comparable. The RES generally expressed erosion severity in terms of visible erosion problems, such as proportions of topsoil lost as of 1934, a 'state' condition. The National Resource Inventories have focused on current rates of soil loss and/or areas needing erosion control or other conservation treatments. To make the two appraisals comparable, it was necessary to research in some detail the land use and management practices that led to the serious conditions observed in the RES, using information for the decade 1925-35 from early soil surveys, localized erosion studies, agricultural censuses and other sources. Along with relevant soils and climatic data, these observations were used to 'reconstruct' erosion rates for a sample of five counties for the base year 1930, employing for this purpose the Universal Soil Loss Equation of Wischmeier and Smith (1978).

The five sample counties are not strictly a random statistical sample, but happen to be counties for which soil survey, erosion studies and other reports were available covering the decade 1925-1935, or five years on either side of the base year 1930. Soil and erosion surveys available for the 28 counties in MLRA 105 are identified in figure 1.

An initial plan was to select Clayton County, Iowa or perhaps Winona County, Minnesota for a pilot study. However, the study team concluded that the results would be more reliable and the research effort proportionately less if changes were analyzed for at least five sample counties, rather than for only one or two areas. The sample counties include: Clayton County, Iowa; Houston County, Minnesota; Winona County, Minnesota; Crawford County, Wisconsin; and Vernon County, Wisconsin. Trempealeau County, Wisconsin and Sauk County, Wisconsin were alternates.

For each of the five sample counties two soil or erosion survey reports have been completed since 1925 (figure 1). The first surveys were generally clustered during the period 1925-1935. In different levels of detail they described customary farming systems and practices during the years 1925-35 and so for the year 1930, the base year for the analysis. Data on crop and livestock production activity in the five sample counties and for the entire 28-county region were compiled for the base year 1930 and then for 1992 to indicate how well the livestock and crop production economies in the sample counties reflect those of the MLRA 105 region as a whole.

The land use and related information for the study drew on three important sources of information centered on the base year 1930: (1) The periodic (5-year) Censuses of Agriculture;

Before view of the Ed Kurth farm, Farmersburg, Iowa, Farmersburg-McGregor Demonstration Project, with terraces at top of the slope. Fields needed rearrangement for contouring and to eliminate gullied lane. Photo from Project files.

1995 repeat photo: Farm now owned by Lou Schrandt shows contour stripcropping and rearrangement of fences. Photo by Douglas Helms. NRCS/USDA. August 1995.

(2) annual crop reports compiled by State Agricultural Statisticians and the National Agricultural Statistics Services (NASS); and (3) cropping and/or management practices followed by farmers as observed in the field by soil or erosion surveyors.

Data on farm numbers, crops grown, livestock numbers, county populations, and income sources are mainly from the Censuses of Agriculture and/or Population (USDC,1927, 1931,1936,1994a,1994b). Additional information on annual crop acres, production and yields was obtained from reports and files of State agricultural statistical agencies, particularly for Illinois (1951), Iowa (1978,1981), and Minnesota (1994). Necessary background data on land uses and crops grown and crop yields in each sample county are in appendix tables A-1 through A-4.

Crop acres for 1930 and crop yields in the sample counties are in tables A-4 and A-5. The yield estimates are expressed as 'expected' rather than observed in the base year 1930, and are computed as averages during the decade 1925-1935. Yield levels and whether the residues are removed and how they are handled through tillage all influence erosion.

Land Use and Production Profiles

Cropping and other land uses for 1930 and 1992 for the five sample counties are consolidated and compared against all 28 counties in table A-1. In 1930 the principal field crops including rotation meadow (item B) were grown on about 71 percent of all croppable land in the sample

Importance of Pasture and Woodland Use for Livestock

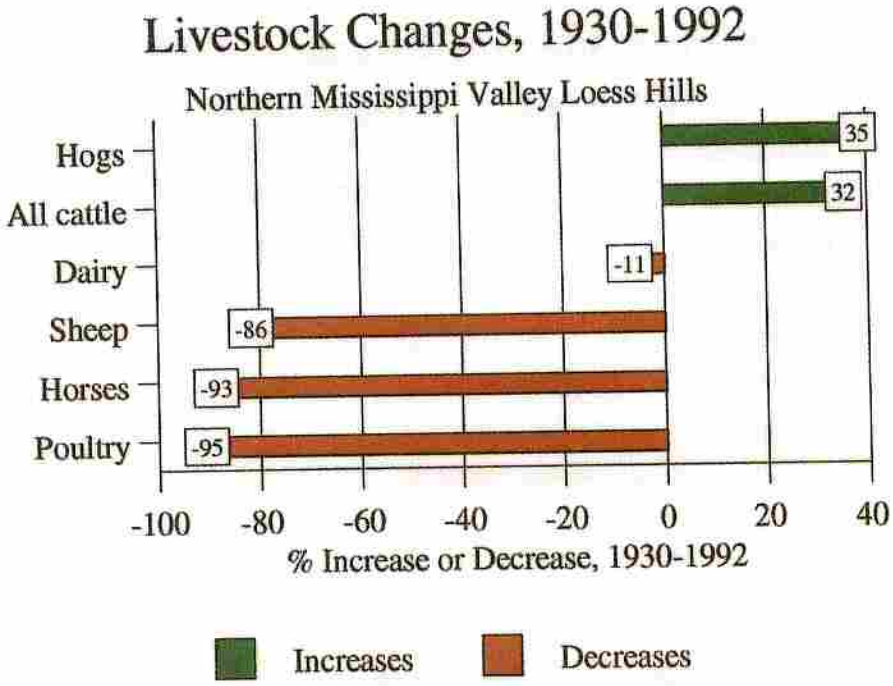
In the five sample counties in 1930, the 574,000 acres of grazed woodlands represented almost two-thirds (63 percent) of the source of grazing land resources, compared with 47 percent in 1992.

For the Coon Creek Basin in Wisconsin covering parts of La Crosse, Monroe and Vernon counties, Trimble and Lund estimated that 88 percent of the woodlands were grazed in 1934, dropping to 27 percent by 1974 (Trimble and Lund,1982,p.8). Our data indicate that the average proportion of woodlands grazed in just these three counties decreased from 80 percent in 1930 down to about 38 percent by 1992. Both sets of data indicate strong preferences in the 1930's for obtaining forages via grazing. Open and wooded pastures occupied large areas and had been grazed continuously for 50-70 years. Woodland grazing was very common, as was the overgrazing of permanent pastures. This not only caused serious sheet and gully erosion on the areas concerned, but also aggravated erosion problems on adjoining cropland.

Several factors help explain the dependence on pasture and woodlands: (1) The dairy farms required a good supply of forage. While there was a tendency to shift land from corn and small grain production to hay crops, this was done on a fairly limited basis. Other livestock farmers placed a relatively high value on cash crops and a low value on hay; (2) any hay needed was usually grown in rotation with corn or small grain feed crops if possible, rather than on permanent hay land; and (3) alfalfa was desired but was costly and in most areas alfalfa needed lime and fertilizer to get started properly. Its acreage was small and apparently limited to the best lands.

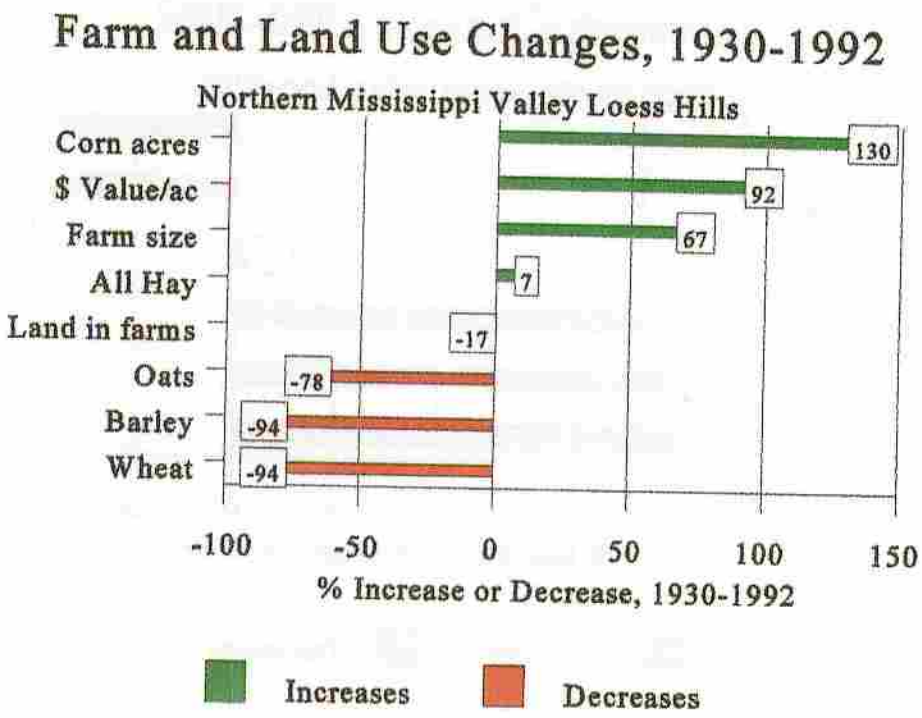
In 1992 only 45 percent of the woodlands were grazed in MLRA 105, compared with over 80 percent in 1930 (table A-2). Overall, the use of farms for grazing purposes has decreased by about 52 percent since 1930, by 64 percent on woodland as such, 45 percent for nonwooded pasture,

Figure 2



In 1930 about 85 percent of all farms in the area reported an average of 5 horses or mules.[5] The percentages were similar for the five sample counties and MLRA 105 as a whole. In those years much of the hay and other crops was needed to support the work stock. In the 1992 Census of Agriculture only 12 percent of all farms reported having horses, mules or ponies; the average in 1992 was also 5 per farm reporting.[6]

Figure 3



farm flocks of poultry, but commercial poultry sales appear to have increased somewhat. The continued growth of the hog and cattle industries provides a ready market for local corn production.

Crops and General Economic Profiles

General changes in land use, crop distributions and other farm indicators are shown in table 3, also in figures 3 and 4. Details on land uses in 1930 in each sample cou[redacted]

Table 2. Livestock inventories and sales in 1930 and 1992 for five sample counties and all 28 counties in MLRA 105

Livestock by classes	Units	5 sample counties 1930	MLRA total 1930	MLRA total 1992	MLRA change 1930-92 [1]
Total number of farms	No.	12,891	71,048	35,230	-51
Livestock Inventories:					
1. Horses, mules, or ponies	1,000	52	298	21	-93
Per reporting farm	No.	5	5	5	0
2. Dairy cows and heifers	1,000	130	724	649	-11
Per reporting farm	No	10	11	50	35
3. Beef cows and heifers	1,000	5	38	283	645
Per reporting farm	No.	9	11	30	172
4. All cattle and calves	1,000	294	1,691	2,235	32
Per reporting farm	No.	NR	NR	90	--
5. Hogs and pigs	1,000	286	1,676	2,270	35
Per reporting farm	No.	NR	NR	310	--
6. Sheep and lambs	1,000	60	455	64	-86
Per reporting farm	No.	NR	NR	40	--
7. Chickens, 3+ months old	1,000	1,138	6,880	313	-95
Per reporting farm	No.	92	105	245	134
Selected Sales Data: [2]					
8. Cattle and calves sold	1,000	NR	NR	1,091	--
Per reporting farm	No.	NR	NR	45	--
9. Hogs and pigs sold	1,000	NR	NR	4,189	--
Per reporting farm	No.	--	--	555	--
10. All chickens sold	1,000	802	4,841	12,813	164
Per reporting farm	No.	82	90	50,000	--

Source: Censuses of Agriculture for 1930, 1935 and 1992.

[1] Data in this column are the total percentage changes between 1930 and 1992.

[2] See table 6 for gross incomes from crops, livestock and livestock products.

NR = not determinable as such from the 1930 Census. -- less than 1 head or less than 1 percent.

Table 3. General economic and crop production profiles for 1930 and 1992 for five sample counties versus all 28 counties in MLRA 105

Economic and crop items	Units	5 sample counties 1930	MLRA total 1930	MLRA total 1992	MLRA change, 1930-92 [1]
Number of farms	No.	12,891	71,048	35,230	-51
Total land in farms	1,000 ac	1,990	11,067	9,185	-17
[illegible]					

In 1992 only 12 percent of the harvested cropland was farmed by tenants who farmed none of their own land, compared with 34 percent in 1930.

The farm economy of MLRA 105, as measured by product sales, remains livestock oriented. In 1992 about 82 percent of gross sales were from livestock or their products, compared with about 50 percent in 1930 (table 3). Crops showing large gains between 1930 and 1992 include alfalfa, corn, soybeans and vegetables. Those losing importance were the small grains and tobacco. In 1992 there were about 184,000 acres of soybeans grown for beans. A few soybeans were grown in 1930 but they were used almost entirely as an emergency hay supply. Soybeans are now a common oilseed crop in the Midwest and other regions, and are an alternative to corn and other field crops, depending on relative prices and production costs for the alternatives.

To examine how typical the land uses patterns in the five sample counties were of the 28-county region in 1930, a paired t-test was made. Two sets of 20 acreages, in 5 row crops, 3 small grains, 5 rotation meadow options and 7 other 'independent' land uses, like pasture and woodlands were compared, taking each acreage item as a percentage of all cropland harvested in each county group. It was concluded that land uses in 1930 in the five sample counties were a very good representation of land use throughout the 28-county MLRA 105. The similarity in 1930 as well as in 1992 of the relative distribution of the main crops in the sample counties and the region is evident in figure 4.[7]

This test and conclusion are important because the distribution of the various crops, associated tillage practices and methods for handling crop residues across the different counties and soils in the region also determines the distribution of values for the cover-management factor **C** in the Universal Soil Loss Equation.

Early Farming Systems Related to Soil Erosion

This review condenses sample county information in soil survey, census and other documents generally dated for the period 1925-1935. Some observations are from soil surveys for

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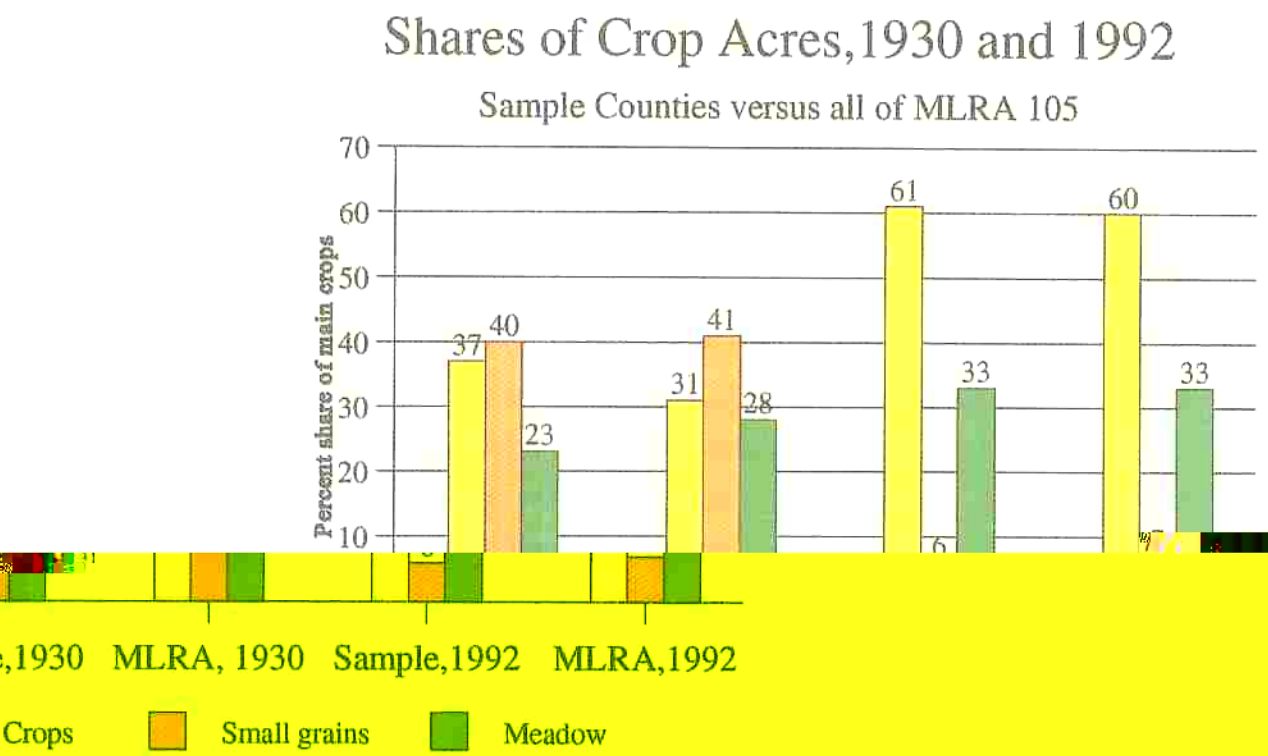
[7] Assuming that each of the 28 counties in MLRA 105 had an equal chance of being included in either the five sampled or the 23 nonsampled counties (having an equal likelihood of having soil surveys done between 1925-35), a t-statistic was used to test the null hypothesis that in 1930 there was no relative difference between the land use patterns of the five 'sampled' and the 23 'nonsampled' counties. The calculated t-statistic, for 19 degrees of freedom, was 0.987, compared to a tabular value of 2.093 for the 95-percent level of confidence. In this case the hypothesis is not rejected.

Figure 4



05, including nearby Dubuque and Clinton Counties in Iowa and nsin. The principal soil or erosion surveys reviewed include those of wn and Nygard (1936), Edwards with others (1928,1930), Gray with heetz (1942), and the Coon Valley report of the Soil Conservation

other counties i Trempealeau Cou Benton and Gray others (1929), Pe Service (1939).

ns

Crop Selection a

dissected valleys nearly all farms in 1930 included some land unsuit early every farm had land that was left as pasture or woodland. This ether with some uncertainty of corn as a reliable crop, helps explain . However, corn remained the most profitable crop to grow except nostly to some Wisconsin counties. Aside from avoiding cultivation f MLRA 105 in 1930, corn was grown as often as possible without ver, only enough corn to feed livestock was produced on the ridge corn led to erosion. As this feature was too serious to ignore, corn

In this area to tilled crops. This disproportion of la farming practices for tobacco, which of the steepest land, regard to surface farms because the